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Shibayama

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(54) **CONTROL SYSTEM FOR STORING DATA IN ACCORDANCE WITH PREDEFINED CHARACTERISTICS THEREOF**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(58) **Field of Search** 707/1, 2, 100, 707/205; 711/133, 136, 154, 158, 159, 160, 167, 202, 209; 710/25, 74

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(57) **ABSTRACT**

A system is provided for controlling storing databases in nonvolatile storages by a program. The database is composed as a set of records. In the system, a record storing reference table and data storing areas are provided. There is provided in the reference table, record identification data for identifying records and storage area designation data for designating a storage area in the nonvolatile storages. The data storing area is provided in one of the nonvolatile storages for each record. In the area, a storing logic record is stored. A storing control means is provided for newly storing a record in a storage area designated by the storage area designation data in the record storing reference table. A storing address information of the record in the storage area is stored in one of the data storing areas. A record stored in a storage area is read in based on the address information.

7 Claims, 15 Drawing Sheets

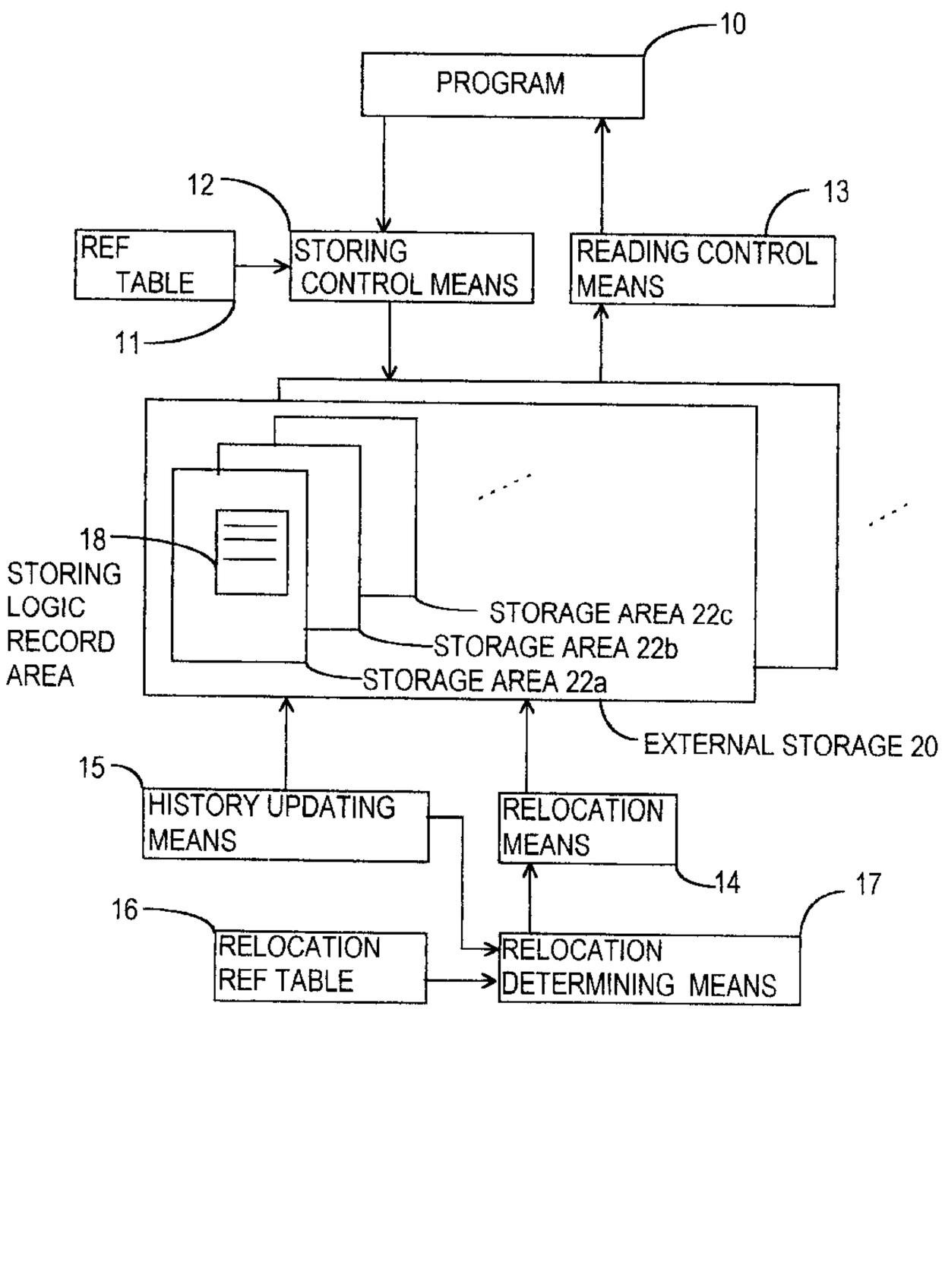

FIG.1

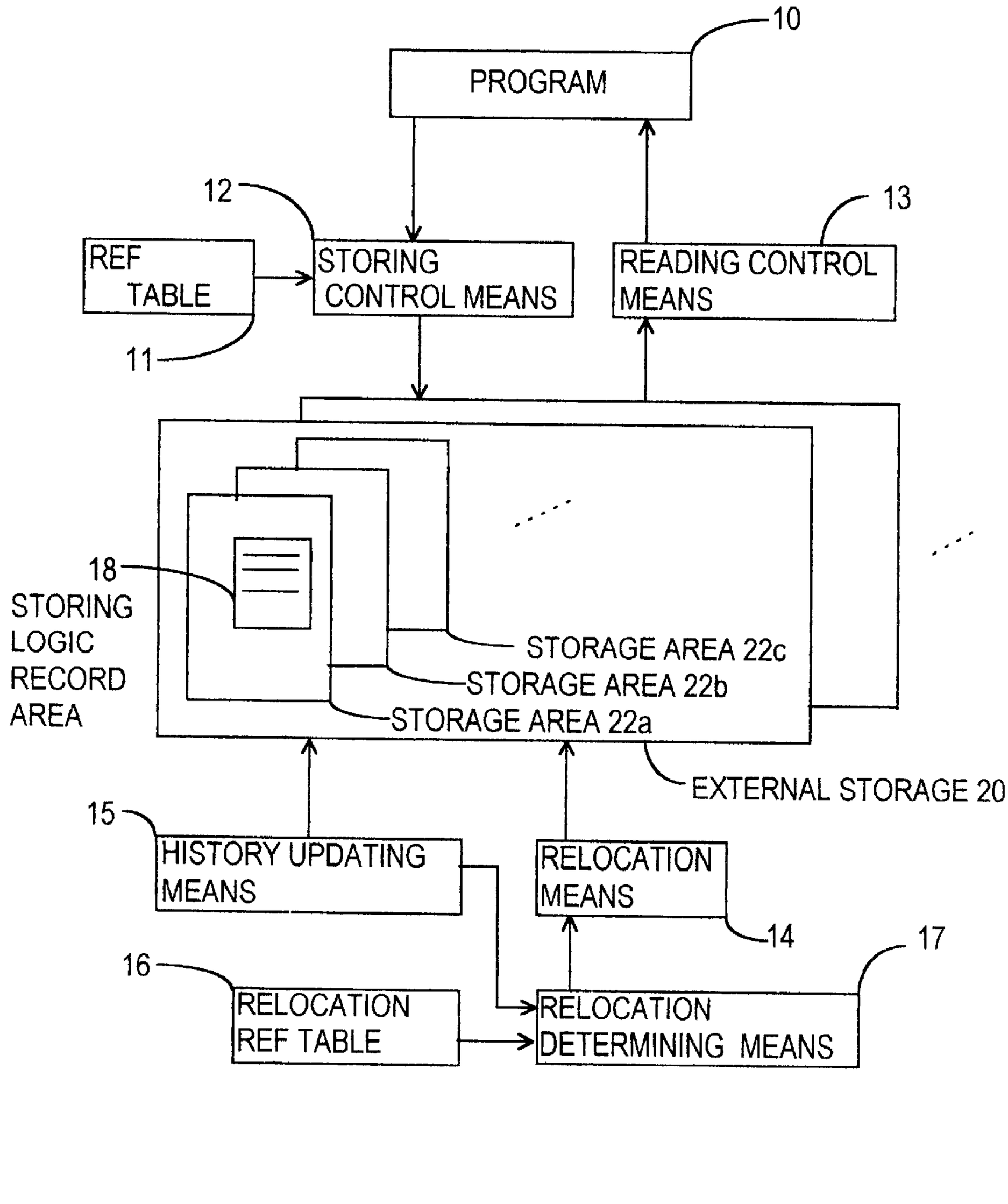
10
PROGRAM
12
13
REF TABLE
STORING CONTROL MEANS
READING CONTROL MEANS
11
18
STORING LOGIC RECORD AREA
STORAGE AREA 22c
STORAGE AREA 22b
STORAGE AREA 22a
EXTERNAL STORAGE 20
15
HISTORY UPDATING MEANS
RELOCATION MEANS
14
17
16
RELOCATION REF TABLE
RELOCATION DETERMINING MEANS

FIG.2

REF TABLE 11

RECORD IDENTIFICATION DATA	STORAGE AREA DESIGNATION DATA
A1	22b
A2	22c
B1	22b
B2	22a
C1	22b

FIG.3

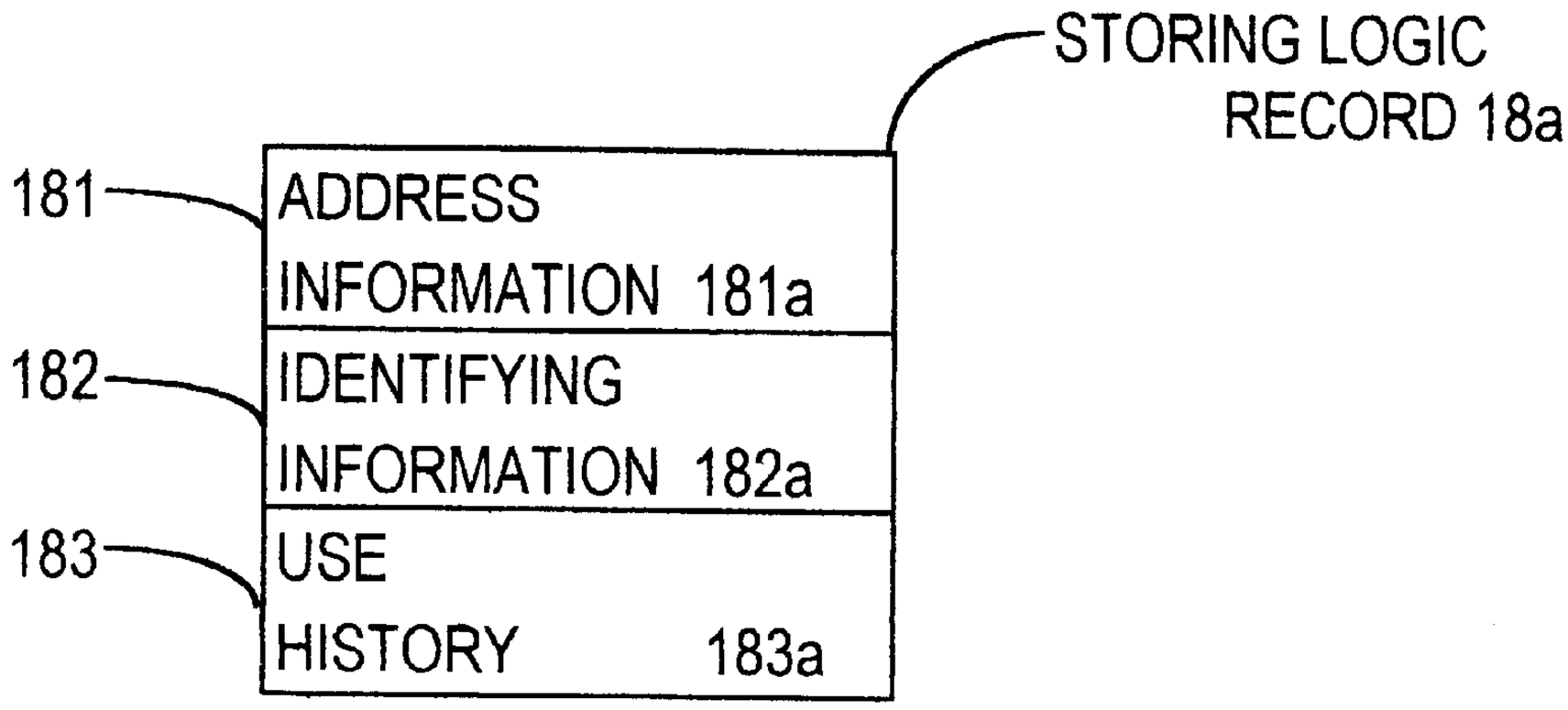

FIG.4

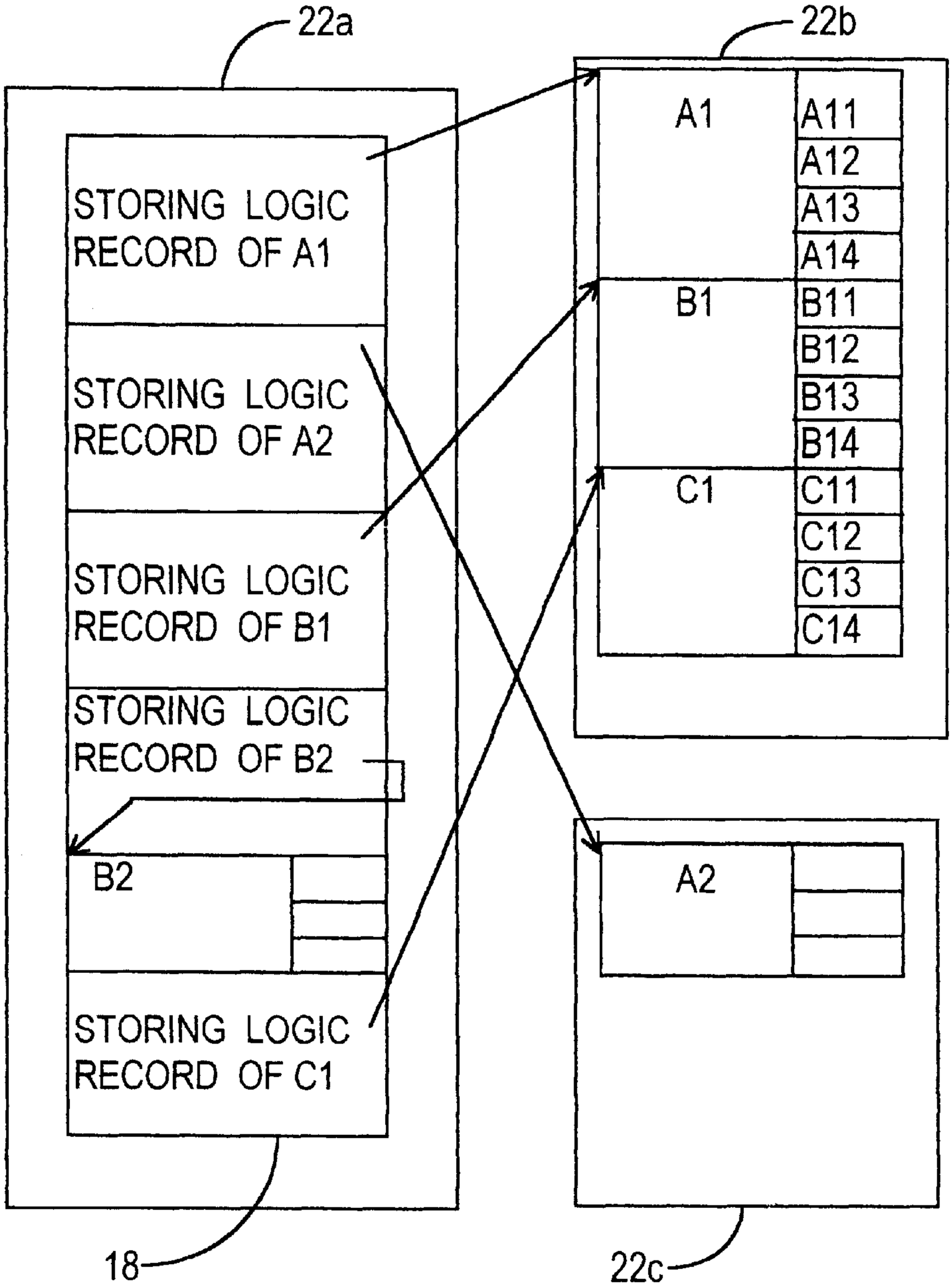
22a
STORING LOGIC RECORD OF A1
STORING LOGIC RECORD OF A2
STORING LOGIC RECORD OF B1
STORING LOGIC RECORD OF B2
B2
STORING LOGIC RECORD OF C1
18
22b
A1
A11
A12
A13
A14
B1
B11
B12
B13
B14
C1
C11
C12
C13
C14
A2
22c

FIG.5

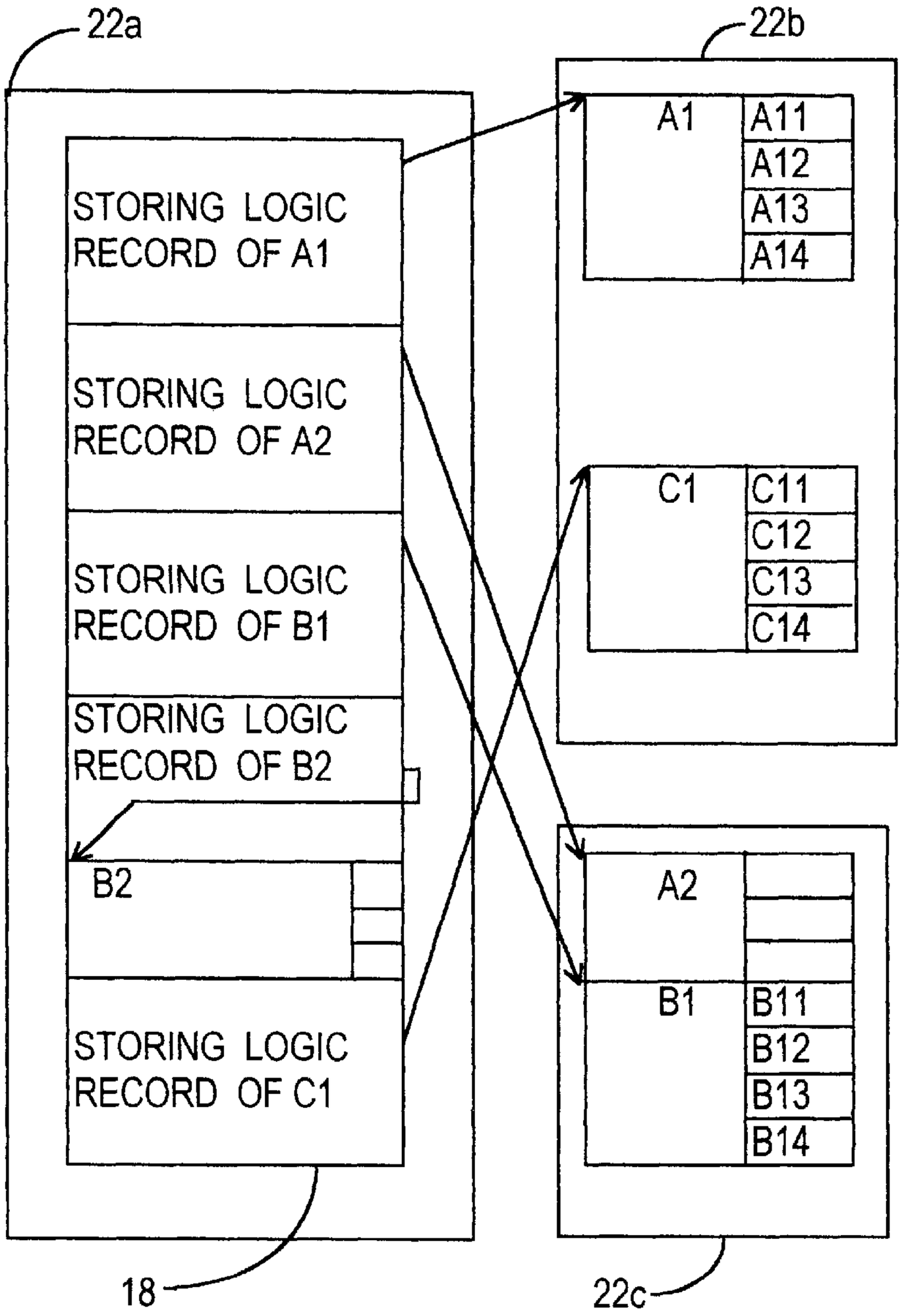

FIG.6

16

IDENTIFICATION DATA 16a	UPPER LIMIT 16b	DESIGNATION 16c
A2	500	22b

FIG.7

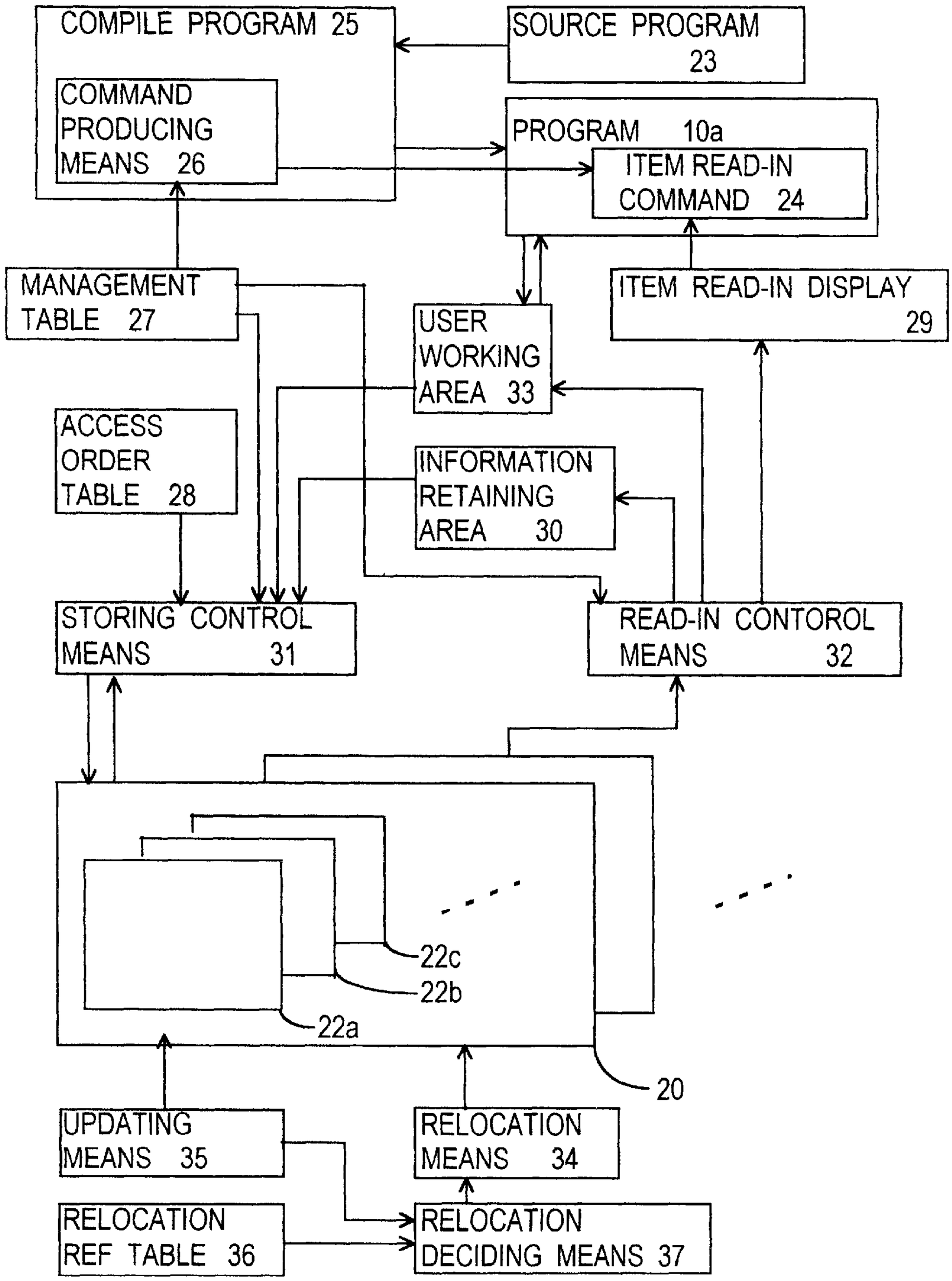
COMPILE PROGRAM 25
COMMAND PRODUCING MEANS 26
SOURCE PROGRAM 23
PROGRAM 10a
ITEM READ-IN COMMAND 24
MANAGEMENT TABLE 27
USER WORKING AREA 33
ITEM READ-IN DISPLAY 29
ACCESS ORDER TABLE 28
INFORMATION RETAINING AREA 30
STORING CONTROL MEANS 31
READ-IN CONTOROL MEANS 32
22c
22b
22a
20
UPDATING MEANS 35
RELOCATION MEANS 34
RELOCATION REF TABLE 36
RELOCATION DECIDING MEANS 37

FIG.8

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DATA ITEM NAME	RELATIVE ADDRESS	DATA ITEM LENGTH	IDENTIFICATION DATA	STORAGE AREA NAME
A11	0	2	1	22b
A12	2	3	2	22a
A13	5	4	3	22b
A14	9	5	4	22c

FIG.9

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STORAGE AREA NAME	ACCESS ORDER
22a	1
22b	2
22c	3

FIG.10

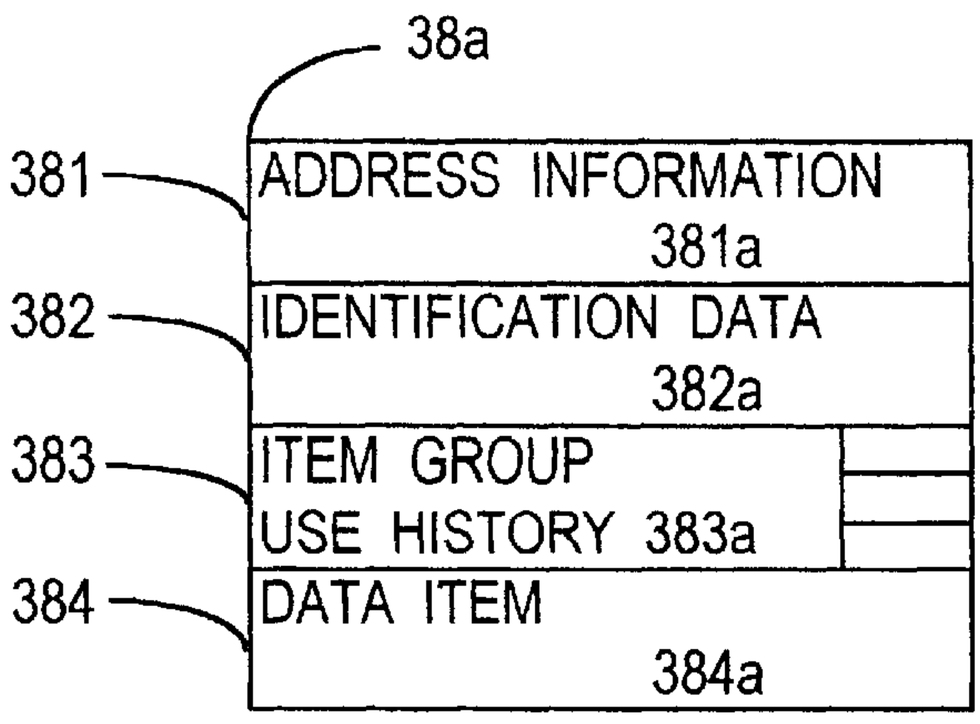

FIG.11

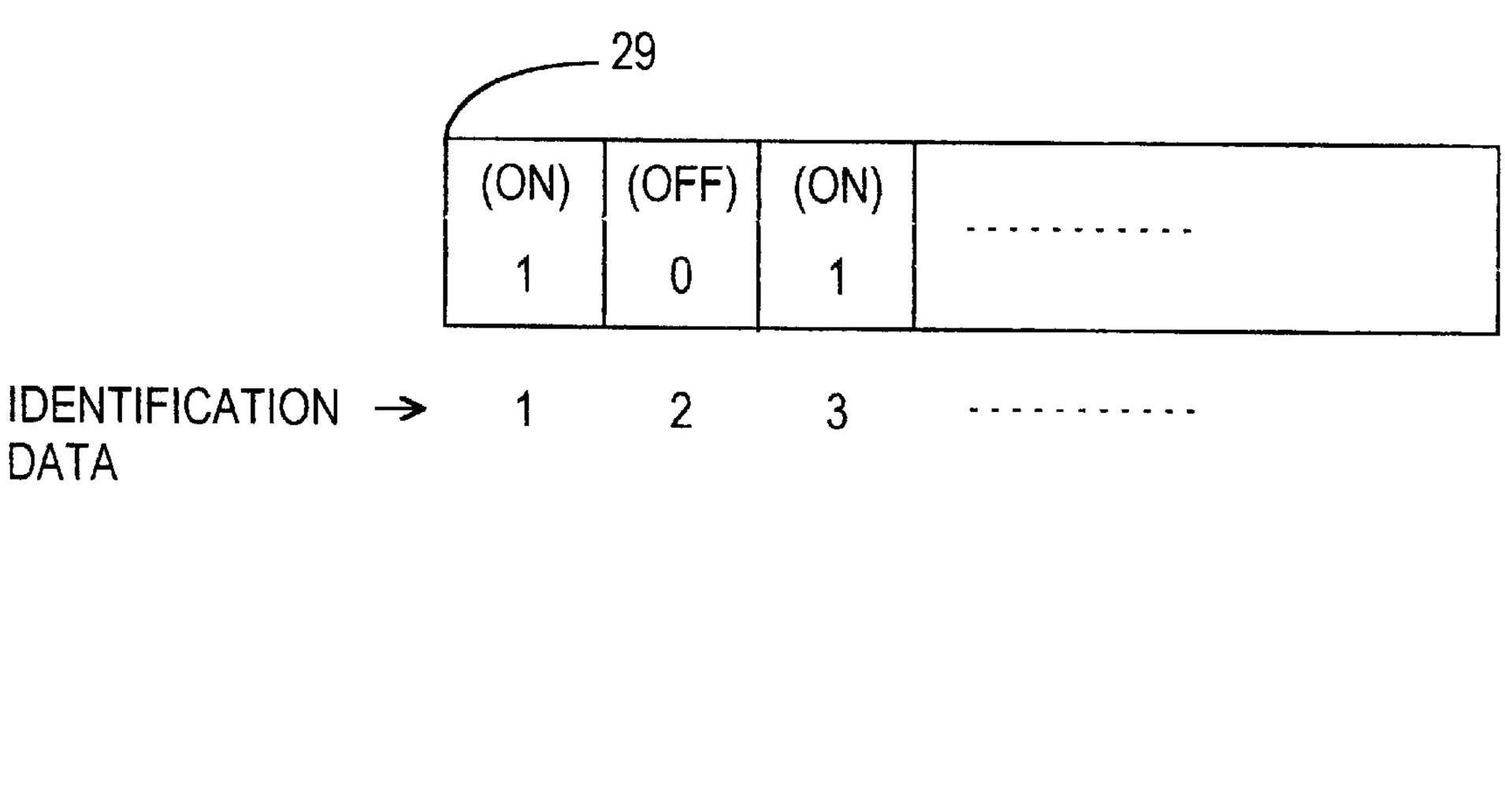

FIG.12

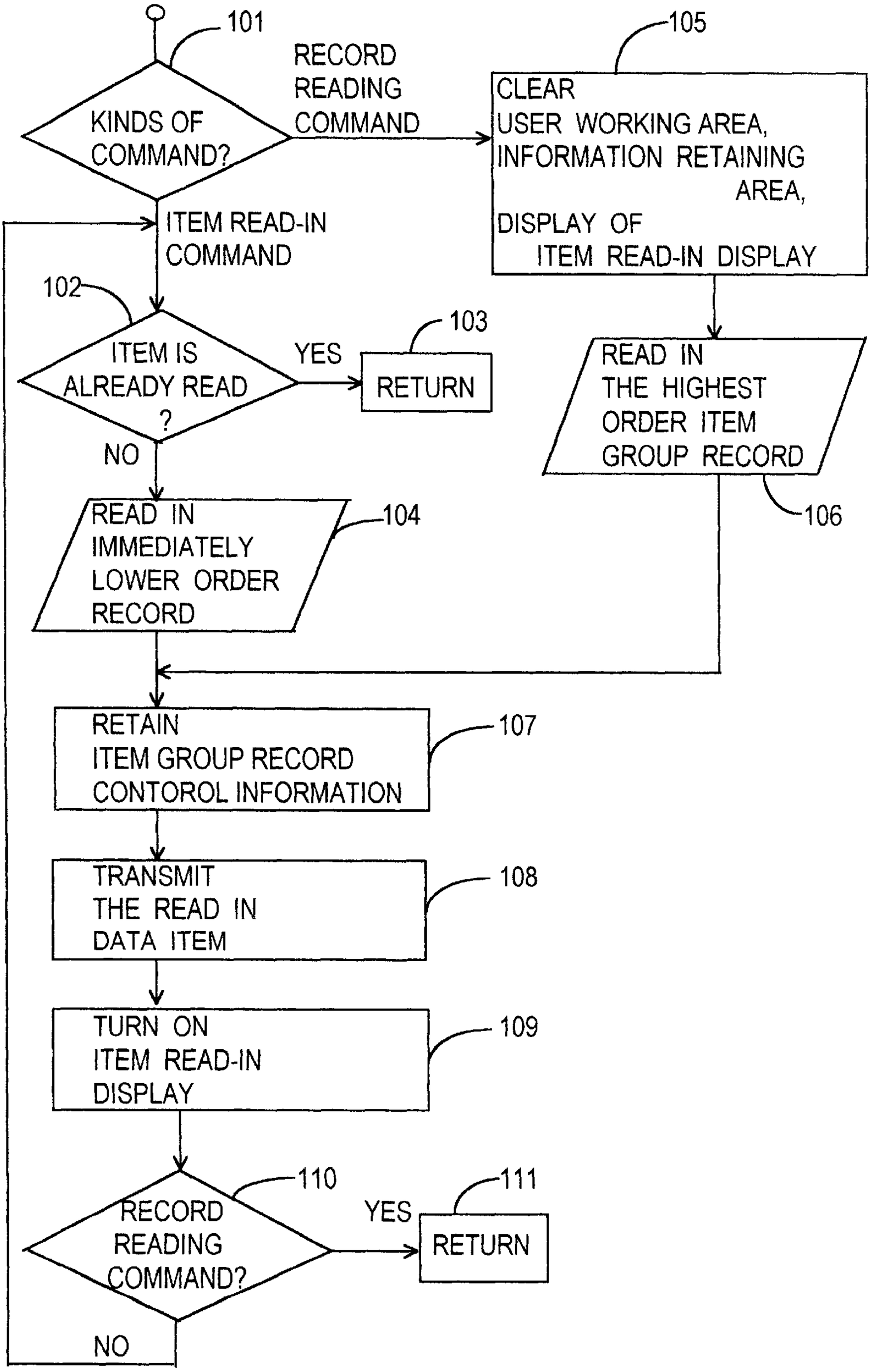
101
KINDS OF COMMAND?
RECORD READING COMMAND
105
CLEAR USER WORKING AREA, INFORMATION RETAINING AREA,
DISPLAY OF ITEM READ-IN DISPLAY
ITEM READ-IN COMMAND
102
ITEM IS ALREADY READ ?
YES
103
RETURN
NO
READ IN THE HIGHEST ORDER ITEM GROUP RECORD
106
READ IN IMMEDIATELY LOWER ORDER RECORD
104
RETAIN ITEM GROUP RECORD CONTOROL INFORMATION
107
TRANSMIT THE READ IN DATA ITEM
108
TURN ON ITEM READ-IN DISPLAY
109
110
RECORD READING COMMAND?
YES
111
RETURN
NO

FIG.13a

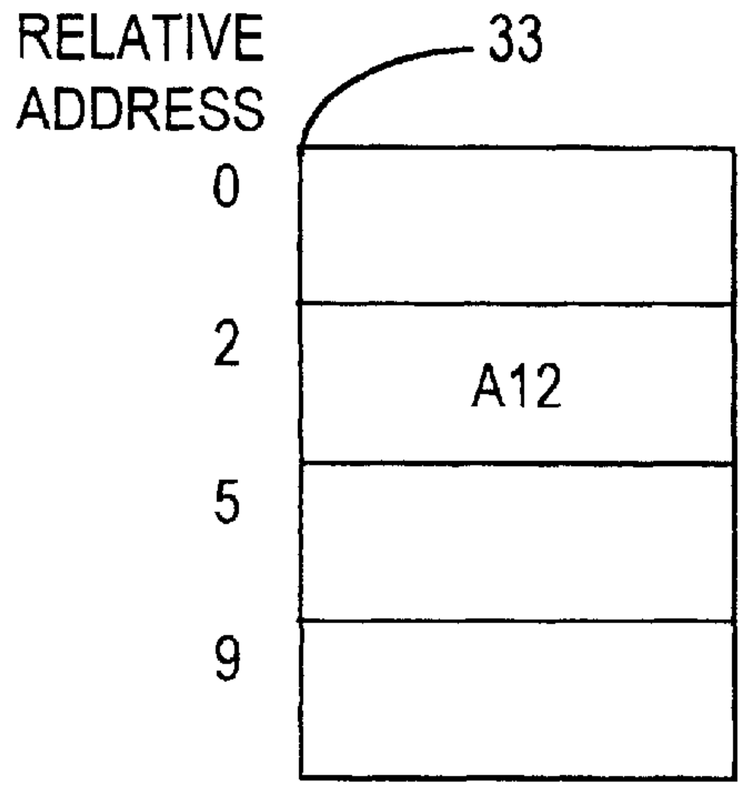

FIG.13b

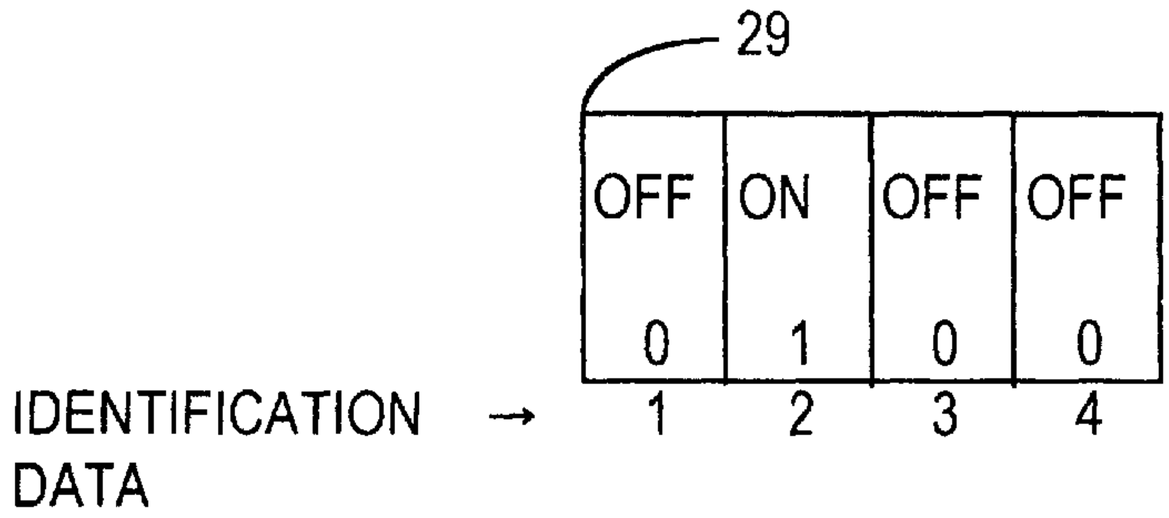

FIG.13c

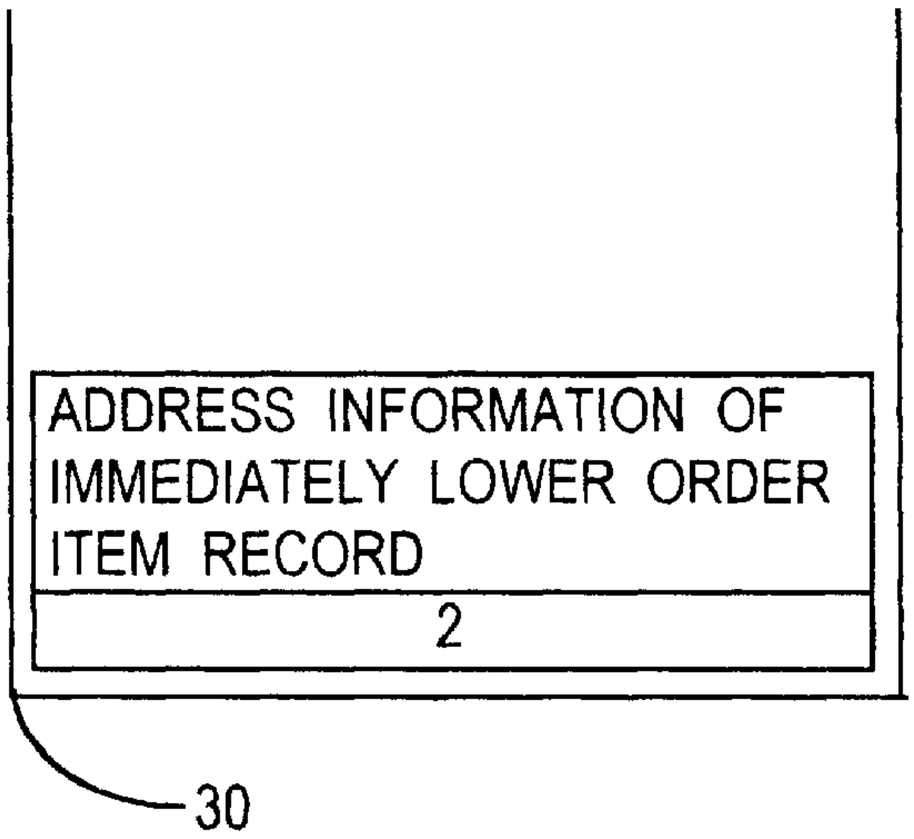

FIG.14a

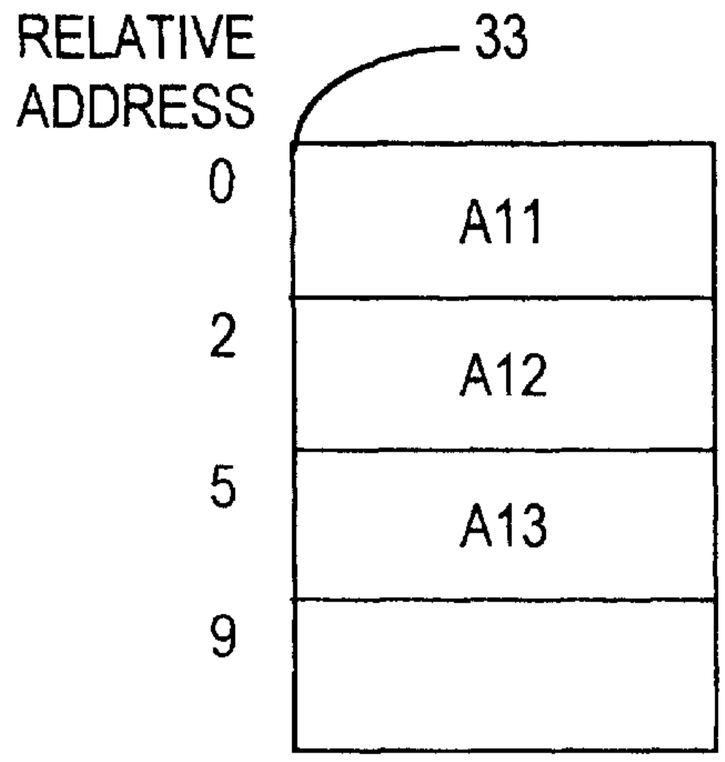

FIG.14b

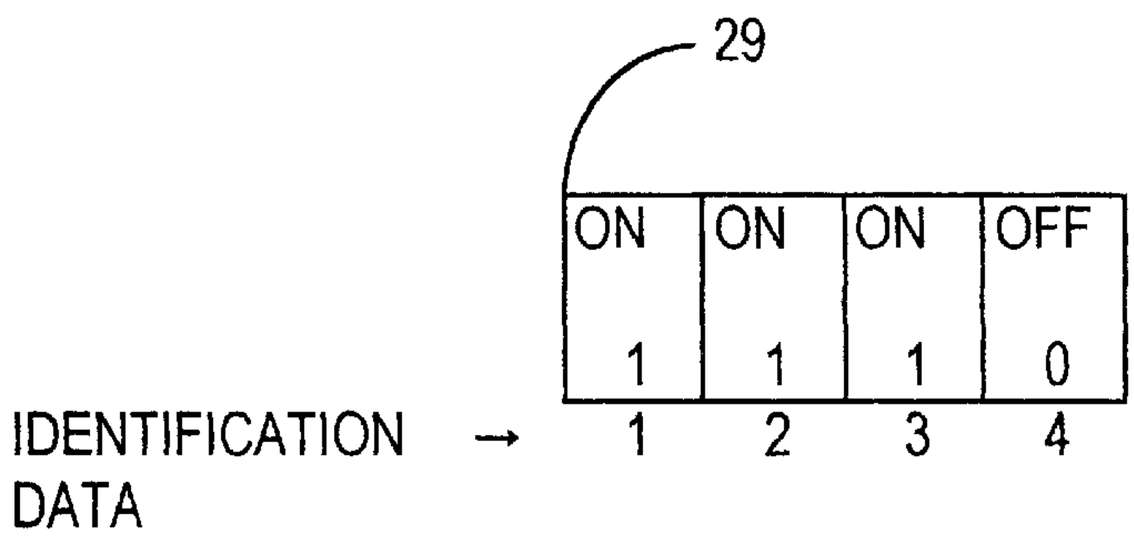

FIG.14c

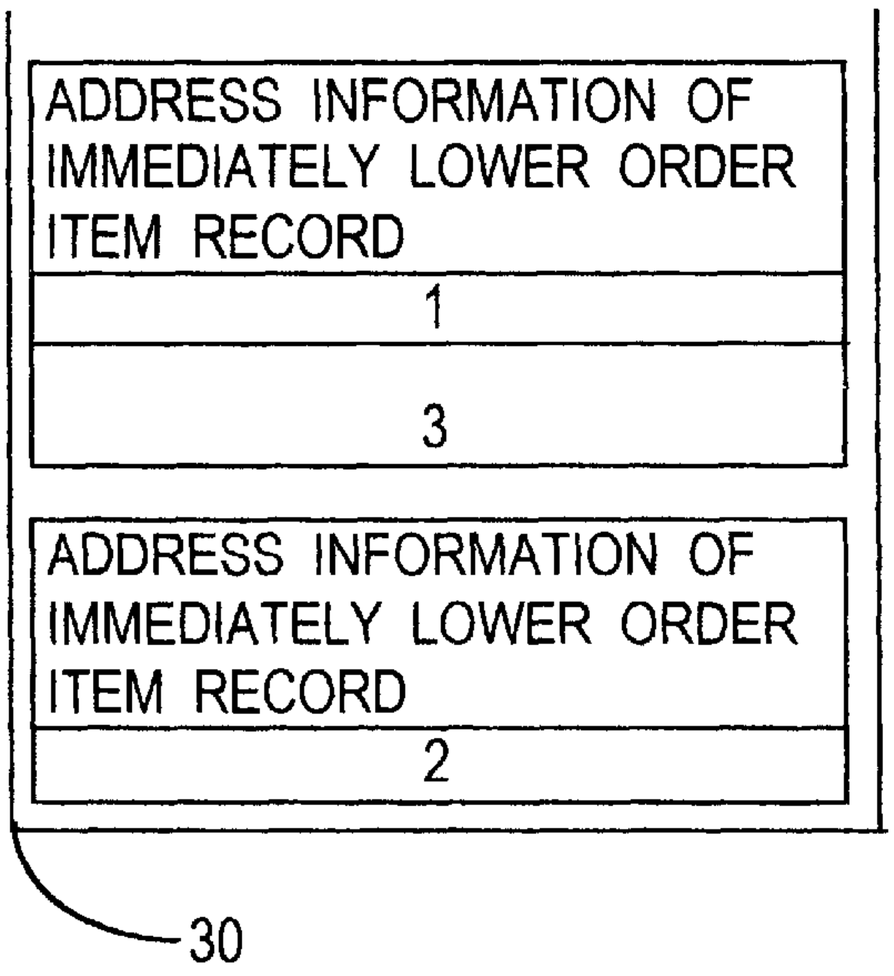

FIG.15

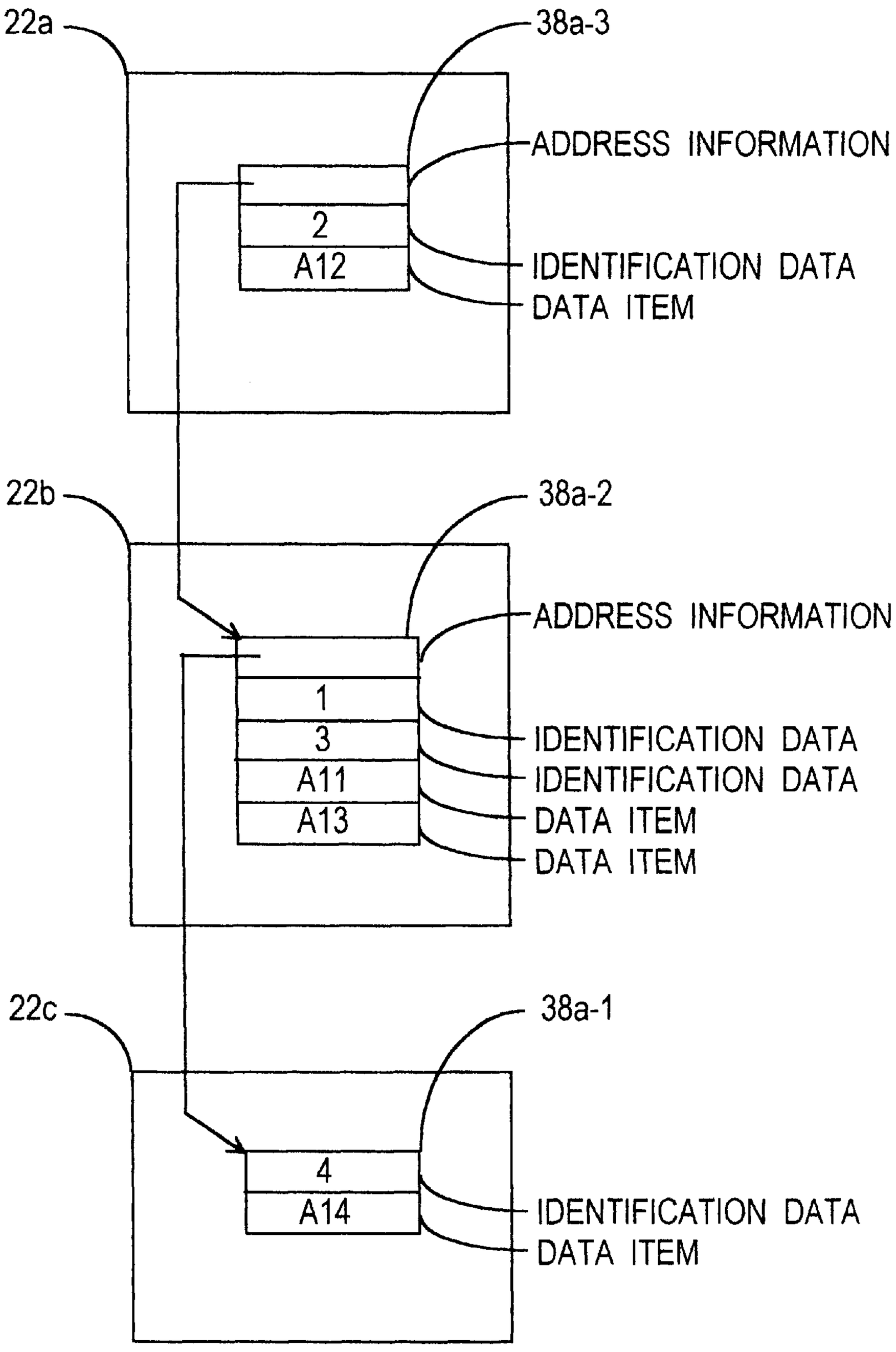
22a
38a-3
ADDRESS INFORMATION
2
A12
IDENTIFICATION DATA
DATA ITEM
22b
38a-2
ADDRESS INFORMATION
1
3
A11
A13
IDENTIFICATION DATA
IDENTIFICATION DATA
DATA ITEM
DATA ITEM
22c
38a-1
4
A14
IDENTIFICATION DATA
DATA ITEM

FIG.16

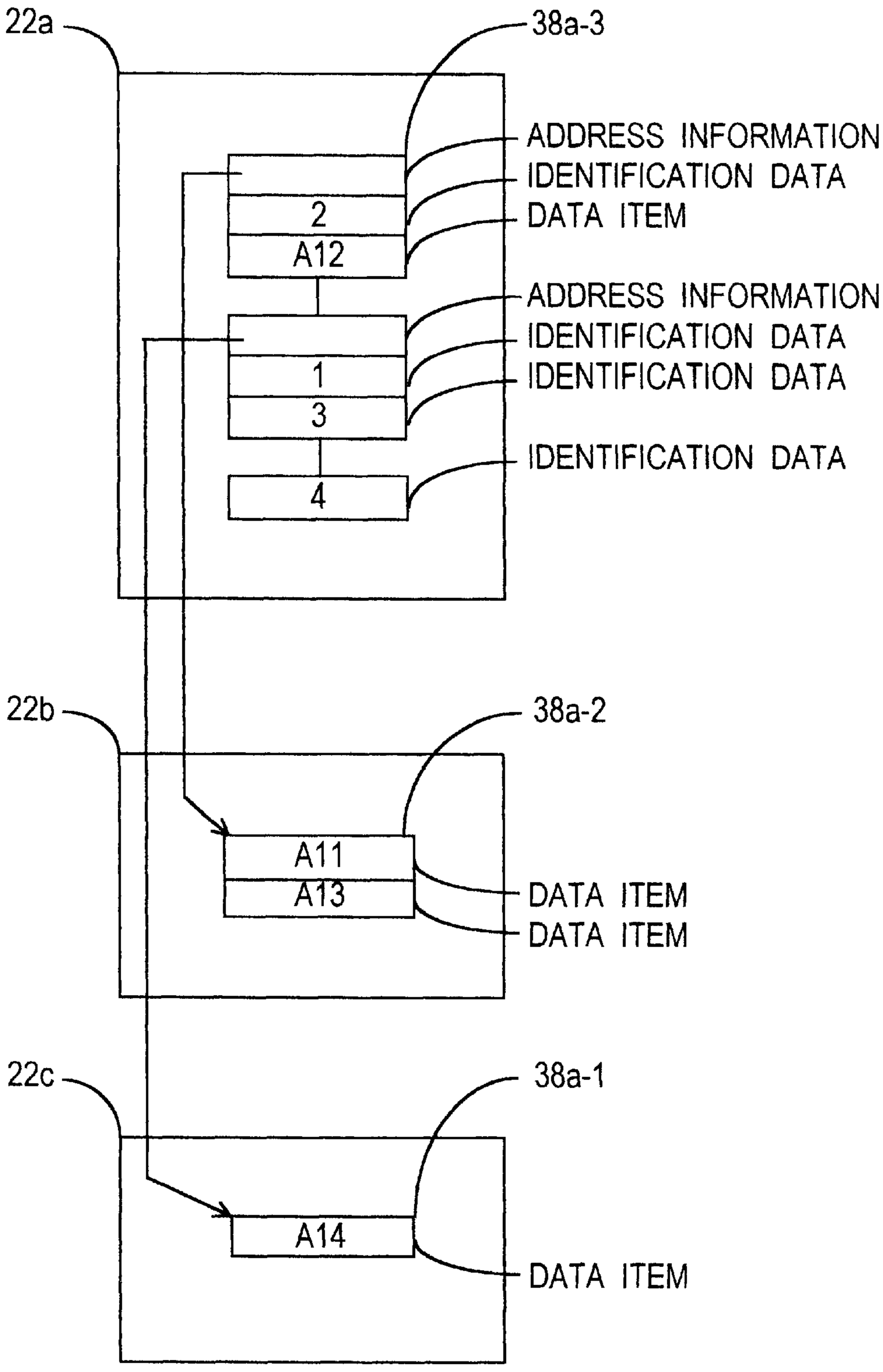
22a
38a-3
ADDRESS INFORMATION
IDENTIFICATION DATA
DATA ITEM
2
A12
ADDRESS INFORMATION
IDENTIFICATION DATA
IDENTIFICATION DATA
1
3
IDENTIFICATION DATA
4
22b
38a-2
A11
A13
DATA ITEM
DATA ITEM
22c
38a-1
A14
DATA ITEM

FIG.17

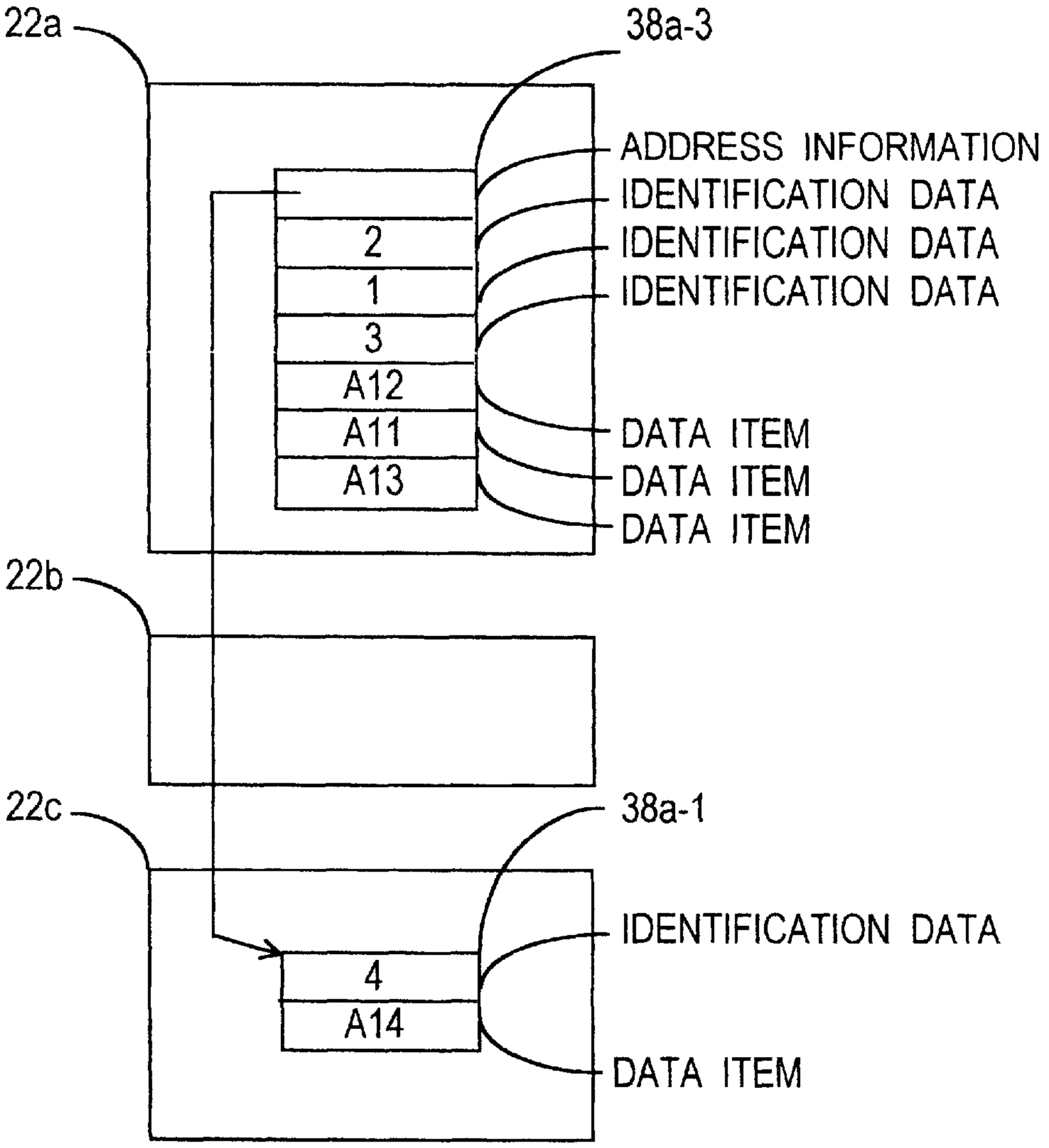

FIG.18

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STORAGE AREA 36a	UPPER LIMIT 36b	STORAGE AREA 36c
22b	500	22a

FIG.19

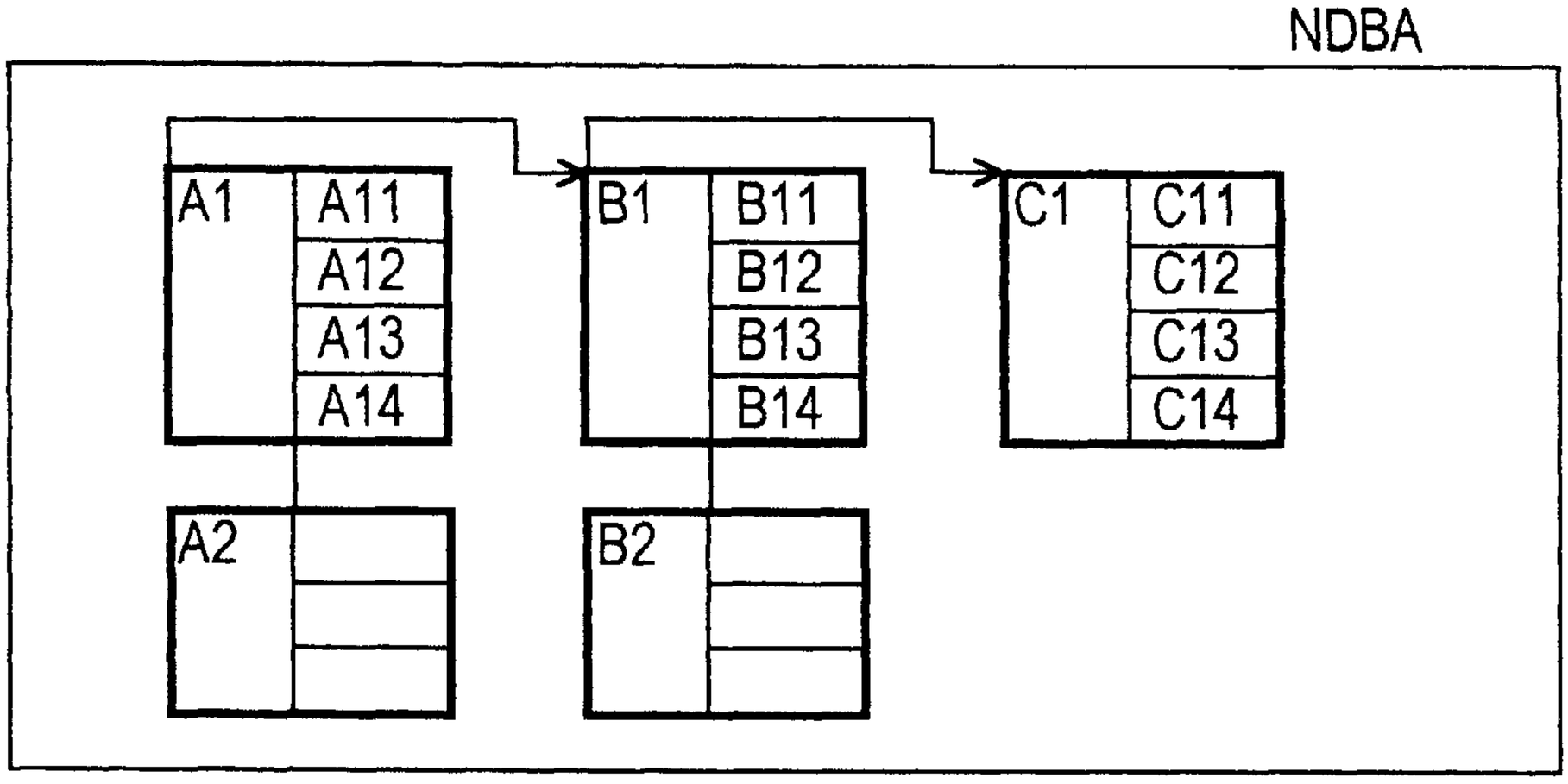

NDBA
A1
A11
A12
A13
A14
A2
B1
B11
B12
B13
B14
B2
C1
C11
C12
C13
C14

FIG.20

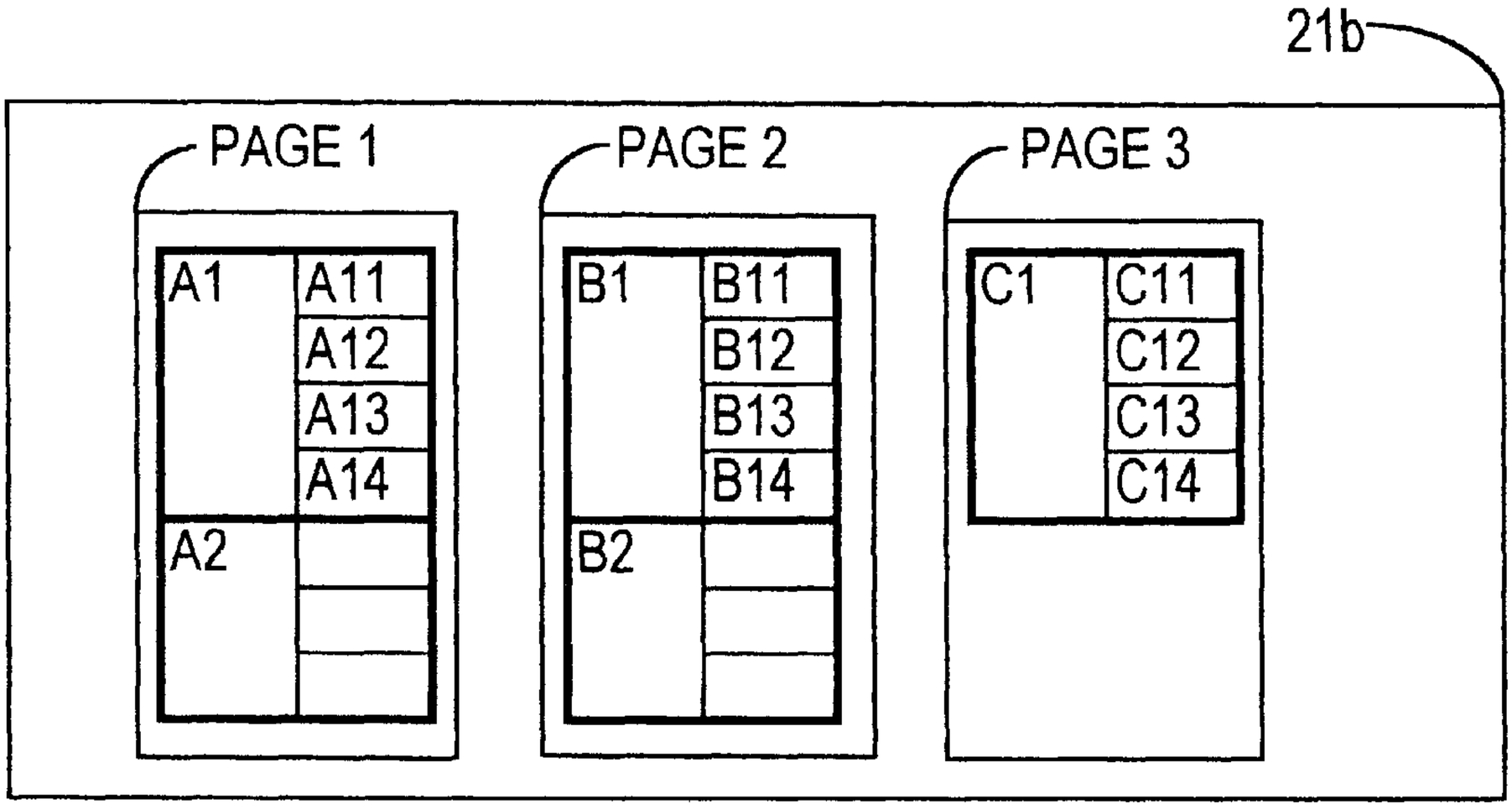

21b
PAGE 1
PAGE 2
PAGE 3
A1
A11
A12
A13
A14
A2
B1
B11
B12
B13
B14
B2
C1
C11
C12
C13
C14

FIG.21

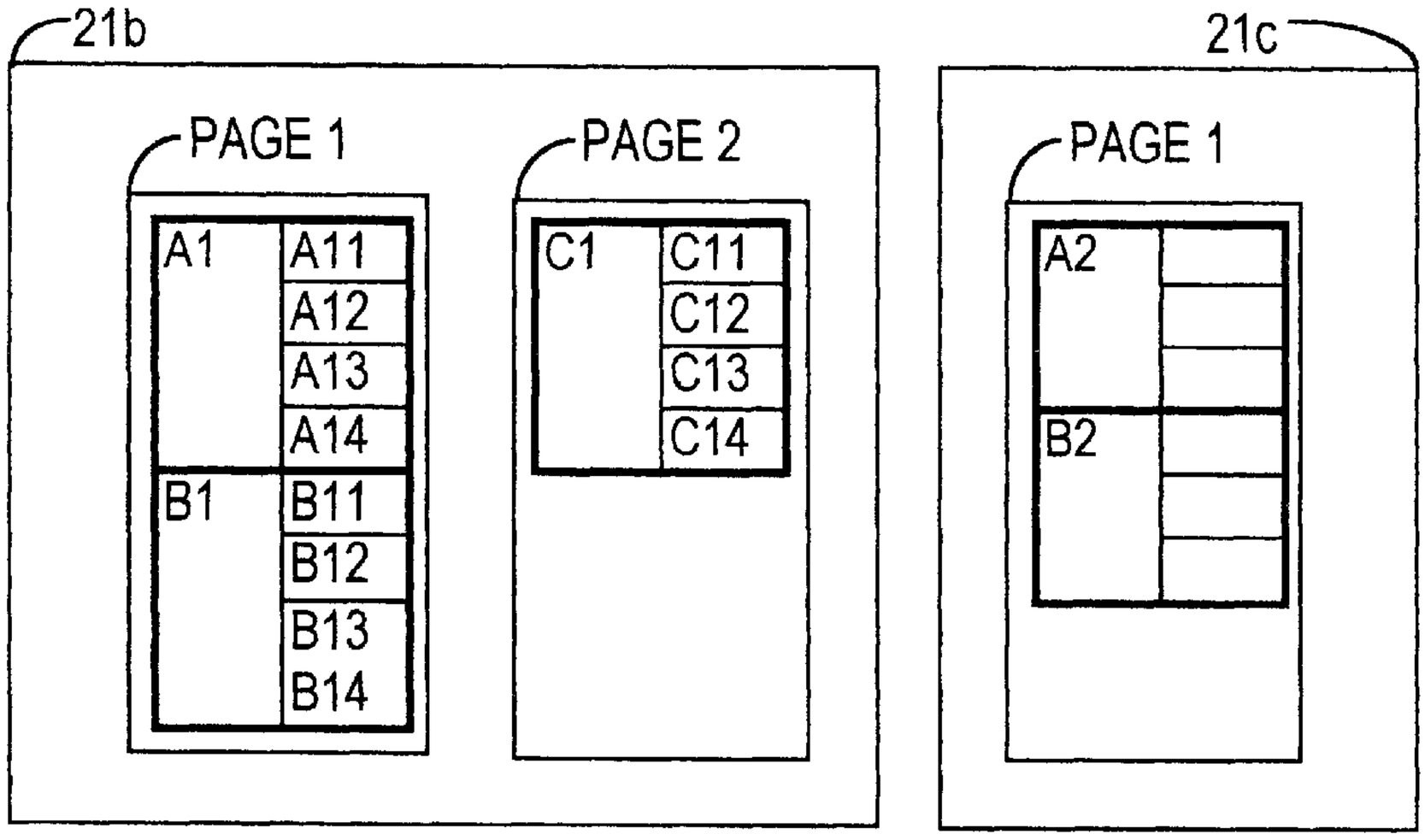
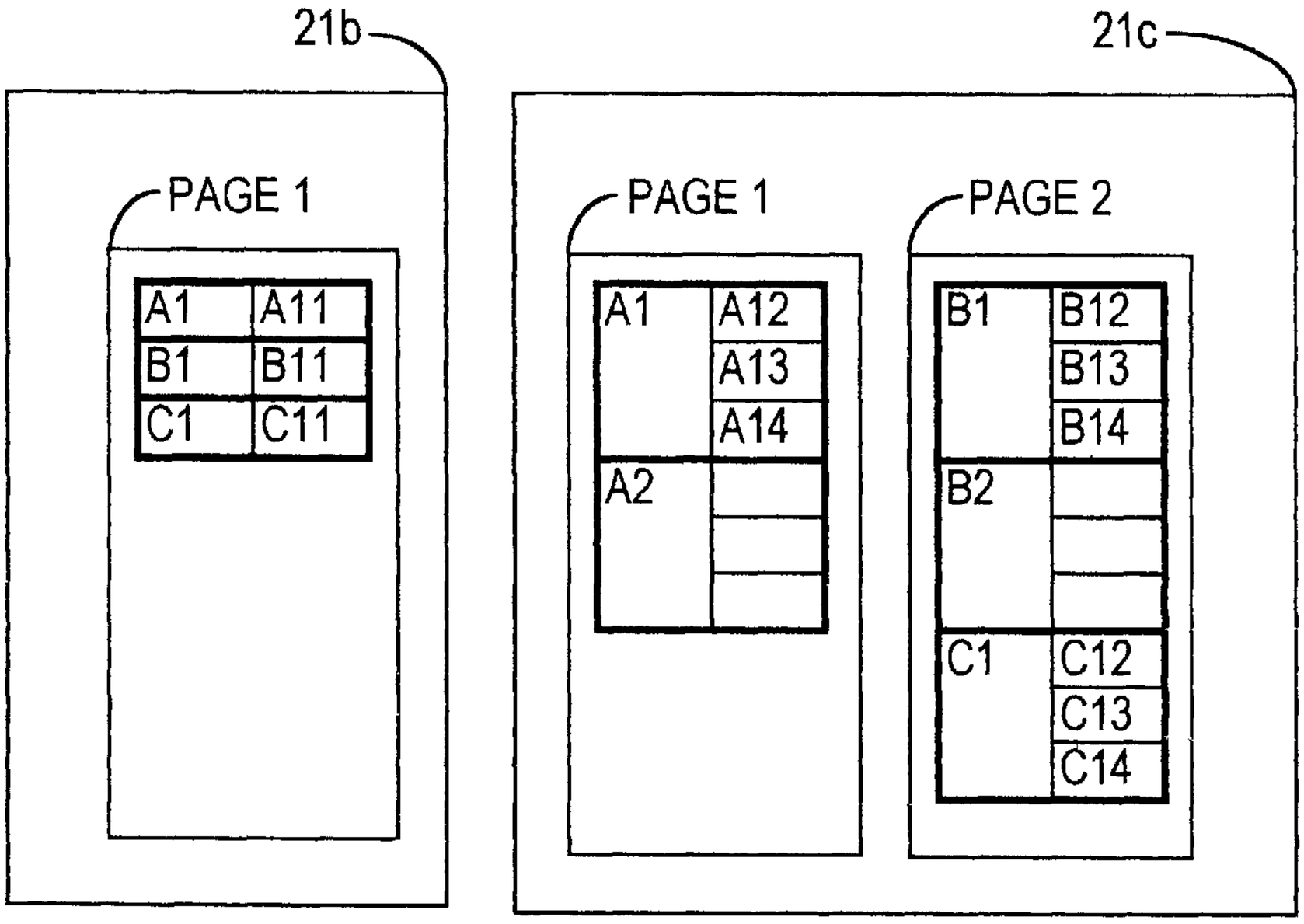

21b
PAGE 1
A1
A11
A12
A13
A14
B1
B11
B12
B13
B14
PAGE 2
C1
C11
C12
C13
C14
21c
PAGE 1
A2
B2

FIG.22


21b
PAGE 1
A1
A11
B1
B11
C1
C11
21c
PAGE 1
A1
A12
A13
A14
A2
PAGE 2
B1
B12
B13
B14
B2
C1
C12
C13
C14

CONTROL SYSTEM FOR STORING DATA IN ACCORDANCE WITH PREDEFINED CHARACTERISTICS THEREOF

BACKGROUND OF THE INVENTION

The present invention relates to a system for controlling the storing of data in a storage of an electronic computer system, and more particularly to a data storing control system in which data are stored and read in by a program.

In a system for storing files blocks and databases in a storage for example in a nonvolatile storage such as a magnetic disk, each of the files blocks and the databases is composed as a set of records, and the record is composed as a set of data items. The program requires inputs and outputs in units of record. Input and output processes between the magnetic disk and a main memory device are performed in units of page or block (hereinafter called page) as a set of records.

FIG. **19** shows a conventional network database (NDBA). The database is composed as a set of a record **A1**, record **A2**, record **B1**, record **B2**, and record **C1**. The record **A1** is a set of data items of **A11**, **A12**, **A13** and **A14**, the record **B1** is a set of data items of **B11**, **B12**, **B13** and **B14**, and record **C1** is a set of data items of **C11**, **C12**, **C13** and **C14**. Each of the records **A1**, **B1** and **C1** is an owner record of indexed sequential organization. Each of the records **A2** and **B2** is designated as a via set of each of the records **A1** and **B1**. Therefore, the records **A1**, **A2**, **B1**, **B2** and **C1** are stored in a storage area **21***b* of the magnetic disk of the FIG. **20** in the arrangement shown in the figure. The program requests input and output in units of record (**A1**, **A2**, **B1**, **B2**, **C1**). However, between the storage area **21***b* and the main memory device, the input and output are carried out in units of page (page 1, page 2, page 3).

In order that the program obtains a desired record in a file or database, it is necessary to decide a head address information of the record wherein the record is stored. It is necessary that the program can exactly read all records even if the number of records changes. Therefore, the storing position of the record is decided by using a positioning logic which is commonly applied to respective records in files or databases. For example, in a sequential organization file, such a positioning logic that a leading position of a record is decided by an address which is obtained by adding the length of the last record to the leading address of the last record.

As another positioning logic, there is provided a logic for a direct organization. The logic is composed in such that a desired record is stored in a page which is decided by hashing a key information for identifying the desired record. In the case that a plurality of records are stored in a page decided by the hashing, the records are detected by using the key information so as to identify the desired record. The key information for deciding a desired record from a plurality of records stored in the same page which is decided by the positioning logic is hereinafter called record identifying information.

In the case that a program uses a data item in a record, the record is read in a predetermined position of a main memory, such as an input buffer or a user working area. The record has a fixed structure in which respective data items are arranged in a predetermined order based on a physical continuity, and the relative address from the head of the record is decided for the data item. Therefore, the head position of the data item is decided by using the relative address from the head of the read in record.

Meanwhile, in the electronic computer system, the shortening of the access time to data stored in an above described storage causes the process time to shorten. The fact that the process time is shortened has important value for the industry in aspects such as the improvement of process efficiency, improvement of productivity, and others.

A first example of a conventional method for shortening the access time will be described hereinafter. Assuming that data necessary for a program are records **A1**, **B1** and **C1** at the database (NDBA) having a structure shown in FIG. **19**, and that the database (NDBA) has a storing structure of FIG. **20**, it is necessary to read three pages of "page **1**", "page **2**" and "page **3**" in storage area **21**b.

On the assumption that, as shown in FIG. **21**, there are two storage areas **21***b* and **21***c*, and the records **A1** and **B1** are stored in the page **1** of the storage area **21***b*, and the record **C1** is stored in the page **2** of the storage area **21***b*, and that the remaining records are stored in a storage area **21***c*, and that the page storing a desired record is already read and stored in the main memory, it is not necessary to read again, the page from the storage area. (This operation is, for example, described in the Japanese Patent Application Publication 7-89334). Therefore, two pages of page **1** and page **2** are read from the storage area **21***b*. As a result, the average access time for the records **A1**, **B1** and **C1** is shortened to ⅔.

There is a case that, in the database NDBA of FIG. **19**, a program requires three data comprising **A11** in the record **A1**, **B11** in the record **B1** and **C11** in the record **C1**. In the case that the database NDBA has the storing structure of FIG. **20**, it is necessary to input three pages comprising the page **1** including the data item **A11**, page **2** including data item **B11** and page **3** including data item **C11**. If there are two storage areas **21***b* and **21***c* as shown in FIG. **22**, and data items **A11**, **B11** and **C11** are stored in the page **1** of the storage area **21***b*, remaining data items are stored in the storage area **21***c*, the average access time for the data items **A11**, **B11** and **C11** is to read only page **1** of the storage area **21***b*, thereby being shortened to ⅓.

The effect on the shortening of the average access time dependent on the adjacent location of records or data items is hereinafter called adjacent location effect. The combination of the records **A1** and **B1** has a higher adjacent location effect than the combination of records **A1** and **A2**. The combination of data items **A11** and **B11** has a higher adjacent location effect than the combination of data items **B11** and **B12**. The aggregating of data of high adjacent location effect is hereinafter called adjacent concentration. As an example of the using the adjacent concentration in the record units, there is the via set specification for a member record of the network database. It is possible to obtain the adjacent concentration effect by specification to a database schema. There is no technique capable of adjacently aggregating data in the units of data item.

As a second method of shortening the access time, the disk cache is used. This method, in the case of using a record on a magnetic disk, is to locate a copy of a page including the record on the disk cache which is an upper storage hierarchy. After the location, the record can be used at the speed of the access time of the disk cache.

A third method for shortening the access time is to move a file or database to a memory of a faster storage hierarchy when the file or database is used in units of the file or database. For example, when a file which is ordinarily located on the magnetic disk is used, the file is moved to an electronic disk. Japanese Patent Laid Open 6-44108 discloses an example of the third method.

Above described second and third access time shortening methods use the storage hierarchy. In the use of the storage hierarchy, the access time can be shortened by locating data having a high probability of use on a higher storage hierarchy. Since the memory capacity decreases as the storage hierarchy becomes higher, it is important to locate the data on the storage hierarchy in accordance with the probability of use of the data for the shortening of the access time.

It is possible to grasp the adjacent location effect in units of the records or data items and the probability of use, by analyzing the internal structure of the program used for the data or by statistically analyzing the past history of action of the data.

In accordance with the above described first method for shortening the access time, although the access time is shortened in all records and data items dependent on the adjacent concentration, the effect is limited to the member record of the network database. In addition, since a schema must be designated in the design stage, an adjacent concentration of an only one fixed pattern for all clusters is implemented. In other words, the first problem of the first method for shortening the access time is that the adjacent concentration can not be implemented in arbitrary record units or in arbitrary data item units.

In the second method, the first access to a page including a desired record to be used must be performed on the magnetic disk. Therefore, the access time shortening effects on only the access to the same page after the first access. Consequently, the page including data to be used can not previously be located on a memory of an upper storage hierarchy. Namely, the storage hierarchy can not effectively be utilized.

In accordance with the third method, although data can be located on an upper storage hierarchy in advance, the location is performed in the file or database units. As a result, even if only a part of data, for example 20% of a file, is used by a program, an upper hierarchy must have a capacity capable of storing 100% of the file. In addition, the upper storage hierarchy is wastefully occupied by 80% of unused data.

The second problem common to the second and third methods for shortening the access time is that the file or the database can not "previously and partially" be located in an upper hierarchy, and hence the access time shortening can not be more effectively implemented.

The reason for the above described first and second problems is that data can not be stored in an a desirable designated storage area in the record or data item units. The reason why data can not be stored in an a desirable designated storage area in the record units is that the position where the record is stored is decided by the positioning logic. On the other hand, the reason why data can not be stored in an a desirable designated storage area in the data item units is that the physical continuity between data items in a record is a precondition.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a system for controlling the storing of data in a memory wherein data can be stored in an a desirable designated storage area in units of a record or a data item, whereby access time can be shortened.

According to the present invention there is provided a system for controlling storing and reading a record, comprising, a plurality of first storage areas, a record storing reference table having a record identification data storing area for identifying records and a storage area designation data storing area in which a storage area proper for a record to be newly stored is designated in accordance with characteristics of the record, a second storage area for storing a storing-logic-record, storing control means for newly storing a record in one of the first storage areas designated by the record storing reference table, and for obtaining address information of the stored record, and for writing the address information in the second storage area as a storing-logic-record, reading control means for reading a record stored in one of the first storage areas in accordance with the address information stored in the second storage area.

These and other objects and features of the present invention will become more apparent from the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a block diagram of a data storing control system of the present invention;

FIG. **2** shows a record storing reference table;

FIG. **3** shows a composition example of a storing logic-record to be stored in the storing logic record storing area;

FIG. **4** shows a storing state when a network database is stored in the storage areas based on the record storing reference table of FIG. **2**;

FIG. **5** shows a storing state after a relocation;

FIG. **6** shows an example of a record relocation reference table;

FIG. **7** is a block diagram showing a data storing control system of a second embodiment of the present invention;

FIG. **8** shows an data item storing management table;

FIG. **9** shows a storage area access order table;

FIG. **10** shows an example of an item group record;

FIG. **11** shows an example of display of an item read-in display;

FIG. **12** is a flowchart of the reading process;

FIGS. **13***a*, **13***b* and **13***c* show states of a user working area, a display and a control information retaining area when a record reading command is given;

FIGS. **14***a*, **14***b* and **14***c* show states of a user working area, a display and a control information retaining area when an item read-in command of identification data of "3" is given;

FIG. **15** shows a state of data items stored in storage areas;

FIG. **16** shows a state that the item group record control information is stored in the upper storage area;

FIG. **17** shows a storing state after relocation;

FIG. **18** shows an example of an item group record relocation reference table;

FIG. **19** shows a conventional network database;

FIG. **20** shows the database stored in a storage area;

FIG. **21** shows three desired records are stored in two pages; and

FIG. **22** shows three desired items are stored one page.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The first embodiment of the present invention will be described hereinafter with reference to FIG. **1** showing a block diagram of a data storing control system of the present invention. The control system is constructed on an electronic

computer system. The control system comprises a program **10** for creating data and using the created data, an external nonvolatile storage **20** such as a magnetic disk for storing records, a record storing reference table **11** for designating a storage area of the external storage in which records are newly stored, a storing control means **12** for controlling the storing of the record based on the program and record storing reference table **11**, a reading control means **13** for controlling the reading of data from the external storage **20**, a record relocation means **14** for changing a storage area (relocation of record) in which a record is stored, and for storing the record in the external storage **20**, a record use history updating means **15** for updating the history of the use of the record, a relocation reference table **16** holding references for the relocation of the record, a record relocation determining means **17** for determining the necessity of the relocation of the record based on outputs of the history updating means **15** and the relocation reference table **16**, and a storing logic-record area **18** in the storage area **22***a* for storing address information as the storing logic-record.

Each of the reference tables **11** and **16** is stored in an internal memory of the electronic computer in a form of a table. The history of the using of record is stored in the storing logic-record area **18** which represents the using history of the record.

The external storage **20** has three storage areas **22***a*, **22***b*, and **22***c*. The program **10** recognizes the storage area **22***a* as a storage area for storing the record.

The storage area **22***b* is provided for storing records, each having a high use frequency and the storing area **22***c* is provided for storing records each having a lower level frequency.

FIG. **2** shows an example of composition of the record storing reference table **11**. In the reference table, record identification data and storage area designation data for designating a storage area for each record are provided.

FIG. **3** shows a composition example of the storing logic record **18***a* to be stored in the storing logic record storing area **18** comprising record areas **181**, **182** and **183**. The storing logic-record **18***a* comprises record address information **181***a*, record identifying information **182***a* and record use history **183***a*, and the storing logic-record **18***a* is provided for each record.

The operation of the data storing control system of the present invention will be described hereinafter with reference to FIGS. **1** to **3**. When the program **10** requires the new recording of a record, for example a record A1, having a high use frequency the storing control means **12** decides the storage area **22***b* for storing the record A1 based on the record identification data by referring to the record storing reference table **11** shown in FIG. **2**, and writes the record A1 in the storage area **22***b*. For the writing, definition of file is preliminary decided in the storage area units, and the record is written by the sequential organization system. The storing control means **12** obtains the address information of the stored record A1 to an address information **181***a* in a storing-logic-record **18***a*. The storing control means **12** further writes the address information **181***a* in the area **181** for the record A1 in the storage area **22***a* by a positioning logic of the program **10**. The storing control means **12** further writes the storing-logic-record **18***a* in the storage area **22***a* by a positioning logic of the program **10**. In the case that the positioning logic needs the length of the record, the length of the storing-logic-record **18***a* is used. The capacity of an area in the storage area **22***a* for storing the storing-logic-record is decided by the length of the storing-logic-record.

In the case that there is record identifying information, the information is included in the storing logic record, and stored together with the storing logic record **18***a*. When a storage area of a record is designated at the same storage area in which an own storing-logic-record should be stored (in the first embodiment, the storage area is area **22***a*, as shown by B2 in FIG. **4**), the record may be combined with the own storing-logic-record and stored.

In the case that a record is rewritten to a storage area, the record and the storing logic record are stored at the original address at the reading. When a stored record is read, the reading control means **13** reads the storing-logic-record **18***a* in the storage area **22***a* by a positioning logic of the program **10**, and further gets the address information **181***a* of the stored record, and reads the stored record based on the address information.

FIG. **4** shows a storing state when the network database of FIG. **19** is stored in the storage areas **22***a*, **22***b* and **22***c* based on the record storing reference table of FIG. **2**.

When the all records A1, B1, C1 of FIG. **4** stored in the storage area **22***b* are necessary, the records may directly be read in sequence. In this case, it is not necessary to read the storing logic record including the address information of the record thereby shortening the access time.

The operation for relocating a record to a storage area different from the previous storage area is hereinafter described, about the case to relocate the record B1 from the storage area **22***b* to the storage area **22***c*. The relocation means **14** reads the record B1 from the storage area **22***b* and writes the record B1 in the storage area **22***c*. The relocation means **14** obtains the address information of the record B1 in the storage area **22***c*, and stores it in the address information area **181** of the storing logic record **18***a* for the record B1.

FIG. **5** shows a storing state after the relocation. Namely, the records A1 and C1 are located in the storage area **22***b*, and the records A2 and B1 are located in the storage area **22***c*. Thus, in accordance with the present invention, the record can be stored in a desirable designated storage area.

FIG. **6** shows an example of the record relocation reference table **16**. The reference table **16** provides identification data **16***a* for the records, an upper limit **16***b* of the number of access times to the storing logic record **18***a* in one day, and designation **16***c* of the storage area.

Operation for automatically relocating a record is described hereinafter. In the system, the storage area **22***b* stores a record having a higher frequency in use of the record. In the record use history area **183** of the storing-logic record area **18**, the number of access time accessing each storing logic record **18***a* in one day (frequency in-use of the storing logic record in one day) is held as the record use history **183***a*. More specifically, the record use history updating means 15 adds 1 to the number of access times in one day in the record use history area **183** at every using of the storing logic record **18***a* in the area **18**, thereby rewriting the record use history **183***a*. Furthermore, the record use history updating means **15** informs the record relocation determining means **17** about the number of access times. The record relocation determining means **17** compares the number of access times in one day with the upper limit **16***b* of the number of access times in one day. When the number of access times of one of the records in the storage area **22***c*, for example the record A2, exceeds the upper limit **16***b*, the record relocation determining means **17** instructs the record relocation means **14** to relocate the record. Thus, the record (A2) in the storage area **22***c* is relocated in the storage area

22*b*. Accordingly, in the storage area **22***b*, only records each having a high frequency in use in one day are stored. For example, in case of the bank account, the number of records of high frequency in use of the record, is very small. Therefore, since the small number of records are stored in the storage area **22***b*, the access time to the desired record can largely be shortened. In other words, the access time is shortened by locating the data on the storage hierarchy in accordance with the probability of use of the data.

As a memory satisfactory for storing above described data, for example, there is "MEMOREX TELEX 6990" (semiconductor disk) having access time of 0.1 msec, and "IBM 3390-1" (magnetic disk) having access time of 16.6 msec. For a file in which all records are stored in a magnetic disk having the same access time as the above described magnetic disk, the inventor of the present invention conducted the following experiment.

All storing logic records and the records were stored in the magnetic disk, and two sets of records were adjacently concentrated in a storage area. Following results of average access times were obtained.

Conventional system: (16.6×2)/2=16.6 msec.

Present invention system: (0.1×2 +16.6)/2=8.4 msec.

In accordance with the present invention, the access time is reduced to about ½.

If the length of the record is 500 byte, and the length of the storing logic record is 20 byte, the weighted average access time in the capacities of the above described two disks is as follows. (0.1×20+16.6×500)/(20+500)=16.0 msec

This demonstrates that the present invention has a higher effect on the shortening of the access time than the effect by speeding up of component in hardware. The number α of records stored in a storage area is follows. (0.1×α+16.6)/α<16.0

The inventor further conducted the following experiments.

Storing logic records and 10% in capacity and 20% in use probability record of the records were stored in the above described electronic disk, 90% in capacity and 80% in use probability record was stored in the magnetic disk. The access time was shortened by the present invention as following results.

Conventional system: 16.6 msec.

Present invention system: 0.1×0.2+(0.1+16.6) ×0.8=13.4 msec

The weighted average access time is as follows. (0.1×(20+500×0.1)+16.6×(500×0.9))/ (20+500)=14.4 msec

FIG. **7** is a block diagram showing the data storing control system of the second embodiment of the present invention.

The control system comprises a program **10***a* having an item read-in command **24**, a source program **23** for the program **10***a*, a compile program **25** having an item read-in command producing means **26**, an data item storing management table **27**, a storage area access order table **28**, an item read-in display **29**, a control information retaining area **30**, an item group record storing control means **31**, a user working area **33** in a main memory (not shown), an item group record read-in control means **32**, an item group record relocation means **34**, an item group record using history updating means **35**, an item group record relocation reference table **36**, and an item group record relocation deciding means **37**.

The item group record using history is one of components of the item group record controlling information, and represents the using history of each item group record composing an aggregation of item group records in the highest order item group record.

The item read-in command **24** commands the item group record read-in control means **32** to read a desired data item in the main memory from the external storage **20** based on an item identification data for storing thereof included in the item read-in command. The external storage **20** is divided into three storage areas **22***a*, **22***b*, and **22***c* similarly to the first embodiment. The program **10***a* recognizes the storage area **22***a* as a storage area for storing files and databases.

FIG. **8** shows an example of composition of the data item storing management table **27**. The table **27** is arranged in the data item units, and comprises the data item name, relative address from a leading address, length of the data item, identification data for storing the data item, and storage area name. The identification data is represented by a natural number in the present embodiment.

FIG. **9** shows the storage area access order table **28**. The table is arranged in the storage area units, and comprises the storage area name, and access order. The storage area **22***a* is provided for storing item group records, each having a high use frequency. As to the access order, the storage area at the front precedence is called high order hereinafter, and the storage area at the behind precedence is called low order. The highest item group record is called the highest order, and the lowest item group record is called the lowest order. Furthermore, the lowest order item group record in the high order item group record is called immediately upper order record for a beneath item group record, and the highest order item group record in the low order item group record is called immediately lower order for an over record. For example, an item group record **38**a-**3** in FIG. **15** is the immediately upper order record for an item group record **38**a-**2**, and the item group record **38**a-**2** is the immediately lower order record for the item group record **38**a-**3**.

The storage area **22***a* is necessarily provided even if no data item to be stored in the storage area is provided. The access order of the storage area **22***a* is the highest order. In the case that there is a plurality of kinds of record in the file or database which are different in layout, the data item storing management table **27** and the storage area access order table **28** are provided by the number of the kinds of records.

FIG. **10** shows an example of an item group record **38***a*. The item group record **38***a* is provided for each item group record. Namely, the item group record **38***a* is a unit for approaching a desired item group record comprising data items stored in the same storage area in order to store individually a data item in the record in an arbitrary storage area. An item group area **38** comprises an area **381** for address information **381***a* of an immediately lower order item group record for the own item group record, area **382** for identification data **382***a* for storing items, area **383** for item group use history **383***a*, and area **384** for data item **384***a*. The aggregation of the address information **381***a*, item identification data **382***a*, and use history **383***a* is called item group record control information hereinafter. The immediately lower order item group address information **381***a* represents the position where an immediately lower item group record is stored. Therefore, the address information is written when the immediately lower order item group record is stored. Consequently, the address information does not exist in the lowest order item group record. The identification data **382***a* represents a data item included in the item group record. The order of the arrangement of the identifi-

cation data is the same as the arrangement order of the corresponding data items. The item group use history **383***a* represents the use history of item group record.

The item read-in display **29** is provided for displaying that a data item of a record is already read in the user working area **33**.

FIG. **11** shows an example of display of the item read-in display **29**. In the drawing, the numeral "1" (ON) for the item identification data "1" and "3" means that the items are already read in a storage area, and the numeral "0" (OFF) for the item identification data "2" means that the item is not yet read.

Operation about an item group record comprising data items **A11**, **A12**, **A13** and **A14** will be described hereinafter. When the program **10***a* commands the system to newly store the record, the item group record storing control means **31** recognizes that the lower most access order is the storage area **22***c* from the storage area access order table **28** of FIG. **9**, and that the data item to be stored in the storage area **22***c* is the data item **A14** from the data item storing management table **27** of FIG. **8**.

The item group record storing control means **31** gets the data item **A14** from the user working area **33**, and gets the identification data "4" from the item storing management table **27**. Thus, as shown in FIG. **15**, an item group record **38**a-**1** is composed and written in the storage area **22***c*, and the address of the item group record **38**a-**1** in the storage area **22**C is obtained. The writing is carried out by the sequential organization system.

Then, the item group record storing control means **31** recognizes that the next access order is the storage area **22***b* from the storage area access order table **28**, and that the data item to be stored in the storage area **22***b* are the data items **A11** and **A13** from the item storing management table **27**.

The item group record storing control means **31** gets the data items **A11** and **A13** from the user working area **33**, and gets the identification data "1" and "3" from the item storing management table **27**. Thus, an data item group record **38***a*-**2** for the data items **A11** and **A13** is composed and written in the storage area **22***b*. The address of the item group record **38***a*-**1** is stored in the area **381** of the item group record **38***a*-**2** as an immediately lower order record address information.

Lastly, the data item **A12** and the item identification data "2" are obtained. Thus, an item group record **38***a*-**3** is composed and stored in the storage area **22***a*.

Operation for reading data will be described hereinafter. When the program **10***a* commands the reading of a record, the item group record read-in control means **32** reads the highest item group record **38***a* from the storage area **22***a*. When the item read-in command **24** is given, it is determined whether the instructed data item is already read or not from the item read-in display **29**. When the instructed data item is not yet read in, the item group record including the instructed data item is read in from a storage area. For example, in the case that the instructed data item is the data item **A13** of FIG. **15**, the item group record **38***a*-**2** is read. If the item group record **38***a*-**3** is stored in the storage area **22***a*, the reading is carried out from the item group record **38***a*-**3** which is the highest order to the item group record **38***a*-**2**. The read in data item (**A13**) is transmitted to a relative address of the user working area **33** based on the data item storing management table **27**. Furthermore, a section of the item read-in display **29** corresponding to the data item is turned on, and the item group record control information is held in the control information retaining area **30**.

FIG. **12** is a flowchart of the above described reading process.

At a step **101**, it is determined whether the command from the program is the record read-in command or the item read-in command. In case of the item reading command, it is determined whether the designated item is already read in or not (step **102**). If yes, the program returns (step **103**). If not, the immediately lower order record in unread records is read in (step **104**), and the program proceeds to a step **107**.

When the command is the record reading command at the step **101**, the user working area **33**, control information retaining area **30**, and the display of item read-in display **29** are cleared (step **105**), and the highest order item group record is read in (step **106**), and the program proceeds to the step **107**.

At the step **107**, the item group record control information is stored in the control information retaining area **30**. The read in data item is transmitted to the user working area **33** (step **108**), thereafter a corresponding section of the item read-in display is turned on (step **109**). Then, it is determined whether the command is the record reading command (step **110**). If it is the case, the program is returned (step **111**). If not, the program returns to the step **102**, and the process is repeated.

FIGS. **13***a* to **13***c* show states of areas **33** and **30**, and display **29** when the command is reading command. FIGS. **14***a* to **14***c* show those states at the item read-in command to read the data item **A13**.

When the command to rewrite the record is given, the item group record storing control means **31** derives necessary data items from the user working area **33** based on the item group record control information held in control information retaining area **30**, and the item storing management table **27**, thereby composing the item group record **38***a*. The item group record **38***a* is returned to the address before the reading.

In the above described data storing control system, in order to obtain the data item **A14** in FIG. **15**, there is necessary three accesses to the storage areas **22***a*, **22***b* and **22***c*. As another storing system, a storing system of FIG. **16** may be provided. In the system, the item group record control information for the item group records in the storage areas **22***b* and **22***c* is stored in the upper storage area **22***a*. In the case, although necessary obtaining quantity of the storage area **22***a* increases, the access to the storage **22***b* is not necessary so that the access time for getting the data item **A14** is shortened.

Furthermore, in the case that there is a plurality of item group records stored in the storage area **22***b* of FIG. **15**, and that all of the records are necessary, the item group records can directly be read in sequence. In this case, it is not necessary to read item group record in the highest order storage area **22***a*, thereby shortening the access time.

In the case that, in spite of necessity of a data item in a record, the program lOa has not the item read-in command **24**, the item read-in command producing means **26** in the compile program **25** produces the item read-in command **24**.

The operation for relocating an item group record to a storage area different from the previous storage area is hereinafter described, in the case to relocate the item group record **38***a*-**2** of FIG. **15** to the storage area **22***a*. The item group relocation means **34** reads the item group record **38***a*-**2** from the storage area **22***b* and writes the read out item group record **38***a*-**2** in the storage area **22***a*. FIG. **17** shows a storing state after the relocation. The relocation of the item group record **38***a*-**2** means that the use frequency of the record increases.

FIG. **18** shows an example of the item group record relocation reference table **36**. The reference table **36** provides the name **36***a* of a storage area in which an item group record necessary for relocation (in this case, the item group record **38***a*-**2**) is stored, an upper limit **36***b* of the number of access times to the item group record in one day, and the name **36***c* of a storage area in which the item group record should be relocated.

Operation for automatically relocating the item group record **38***a*-**2** is described hereinafter. In the record use history area **383** (FIG. **10**) for the item group record **38***a*-**2**, the number of access times accessing to the item group record **38***a*-**2** in one day (frequency in use of the record in one day) is held as the item group record use history **383***a*. More specifically, the item group record use history updating means 35 adds 1 to the number of access times in one day in the item group record use history area **383** at every using of the item group record **38***a*-**2** in the area **383**, thereby rewriting the item group record **38***a* including the use history **383***a*. Furthermore, the item record use history updating means **35** informs the item group record relocation determining means **37** about the number of access times. The item group record relocation determining means **37** compares the number of access times in one day with the upper limit **36***b* of the number of access times in one day. When the number of access times of the item group record **38***a*-**2** exceeds the upper limit **36***b*, the item group record relocation determining means **37** instructs the item group record relocation means **34** to relocate the item group record **38***a*-**2**. Thus, the item group record **38***a*-**2** is relocated to the storage area **22***a*. Accordingly, in the storage area **22***a*, only records each having a high frequency in use in one day are stored.

In accordance with the present invention, the access time is shortened.

While the invention has been described in conjunction with preferred specific embodiment thereof, it will be understood that this description is intended to illustrate and not limit the scope of the invention, which is defined by the following claims.

What is claimed is:

1. A system for controlling storing and reading a record, comprising;

a plurality of first storage areas;

a record storing reference table having a record identification data storing area for identifying records and a storage area designation data storing area in which a storage area proper for a record to be newly stored is designated in accordance with characteristics of the record;

a second storage area for storing a storing-logic record;

storing control means for newly storing a record in one of the first storage areas designated by the record storing reference table, and for obtaining address information of the stored record, and for writing the address information in the second storage area as a storing-logic-record;

reading control means for reading a record stored in one of the first storage areas in accordance with the address information stored in the second storage area.

2. The system according to claim **1** further comprising record relocation means for relocating a designated record in a storage area different from a previously located storage area.

3. The system according to claim **2** further comprising a relocation reference table having a reference for determining relocation of records, record use history updating means for storing number of uses of record in one of the data storing areas as a use history, and for at every use of the record, record relocation determining means for determining relocation of a record based on the reference in the relocation reference table and the use history, the record relocation means being provided for relocating the record in accordance with determination of the record relocation determining means.

4. A system for controlling storing and reading a data item, comprising:

a plurality of storage areas;

a data item storing management table having a relative address, length, identification data of each of data items of each item group records, and name of a storage area in which a data item is to be newly stored;

a storage area access order table having the name of the storage area and data representing access order of the data item;

areas each of which is provided for composing one of the item group records;

storing control means for newly storing a data item in a storage area designated by the data item storing management table; and

read-in control means for reading an unread data item in response to an item read-in command and for transmitting a read-in data item to a predetermined memory area.

5. The system according to claim **4** further comprising item group record relocation means for relocating a designated item group record in a storage area different from a previously located storage area.

6. The system according to claim **5** further comprising an item group record relocation reference table having a reference for determining relocation of item group records, item group record use history updating means for storing number of uses of item group record in one of the data storing areas as a use history, and for at every use of the item group record, item group record relocation determining means for determining relocation of an item group record based on the reference in the relocation reference table and the use history, the item group record relocation means being provided for relocating the item group record in accordance with determination of the item group record relocation determining means.

7. The system according to claim **1** wherein the second storage area is provided in one of the first storage areas.

* * * * *